steam shovels, supplies. As the river rises slowly any weak point in the defences is noted and reinforcement rushed in. The Gila on the contrary is a flashy stream. A big, general rain over Arizona, especially if it finds snow to melt, will start a flood overnight. In January, 1916, the flow of the Gila, entering the Colorado just above Yuma, increased from 1,300 second-feet to nearly 200,000 second-feet in five days. There is little time to prepare for such a flood, tó build up an organization to fight it. Dangerously high stages in the Gila have occurred but three times in the last 20 years. Fortunately the river drops almost as fast as it rises. A break in the levees may cause damage but it can be soon mended. Where the Colorado floods are formidable for weeks, the Gila floods are measured in days.

These problems can be solved. In the great canyon of the Colorado which crosses northern Arizona there are a number of favorable sites where a dam could impound a whole year's flow of the river. It is estimated that the power development alone would pay for such a dam. At present there are many matters in dispute over the building, questions as to best location, as to water and power control, as to State rights and national rights, as to Government or private construction. But these questions can be settled and the dam will be built, and with its building will pass the problem of floods and low water in the lower Colorado River. A river shorn of its floods will cease to be a menace to development; a river with even flow throughout the year will not only provide abundantly for the needs of present irrigated areas, but will permit the development of acreage three or four times as great. The problem of the Gila is being solved gradually. Construction of the Roosevelt Dam was the first step, another dam in the Salt River and two in the Verde already provided for will help as much again. By the time the great Colorado Dam is built it is probable that the Gila will be largely shorn of its power, also, and these problems of the lower Colorado will cease to be. It is part of the passing of the old West and the coming of the new.

551.466.78 (282.271)

TIDAL BORE AT MOUTH OF COLORADO RIVER DECEMBER 8 TO 10, 1923

By JAMES H. GORDON

[Weather Bureau, Yuma, Ariz., December 1923]

The lower delta country, as observed on this trip, is a great level plain so flat that the elevation probably did not vary a foot in the 25 miles crossed. The ruts which formed the road furnished the greatest variation in elevation observed. The plain is almost entirely destitute of plant growth. A liberal estimate would be one small bush to every hundred acres. There was a strong wind blowing. My hat went off. One of the men sprang after it, but was distanced. Because of recent rains it was unsafe to leave the road and follow "cross country." We did not follow the road which trended southeast while the hat went straight south. The hat was kept in sight for more than 3 miles and in that distance there had not been so much as a bush to check it in its mad flight. This to illustrate the character of the country. There are no recognizable channels across it except occasional drainage lines a few inches deep. Water from the Colorado at flood times and from overflow tides must cross this plain to reach Laguna Salada, which they are supposed to feed. The elevation of the plain is given as 8 feet at the northern end and 7 a little distance south of La Bomba.

While crossing this open country Pinto Mountain was observed. It is an isolated peak 1,500 to 1,800 feet high, rising abruptly from the western edge of the plain just south of the entrance to Laguna Salada. It is normally dark in color with its steep slopes grotesquely spotted with big patches of sand, some probably fully an acre in extent. Apparently the high north winds blowing down the Laguna Salada Valley pick up nearly their maximum load of sand. Eddies and swirls on the lee side of the mountain check the wind velocity enough to cause a dropping of the sand load. Time did not permit a close study of the mountain.

About 3 miles from La Bomba the road ran into water. It was shallow but extensive, so we left the cars and waded. The water was nowhere more than 6 inches deep, underlaid with a very adhesive mud, and covered perhaps half of the distance. A few "islands" were fairly dry. The rest of the way was mud. The water came from a tidal overflow of two nights previous and would require, we were told, two more days to drain off.

The "city" of La Bomba, the "seaport" of this section of Mexico with two small steamers a week, consists of seven small buildings, including a radio station, and at the time of our visit boasted five inhabitants and seven automobiles and trucks. The "port" is a slushy, crumbling river bank. I did not witness the method of unloading freight but with a normal tidal range of fully 12 feet, strong river and tidal currents and only a crumbling mud bank to work from it must present many difficulties. The freight brought in is mostly liquor for the border towns while fish are shipped south. The "city" is flooded about 6 inches deep every new moon, we were told, and at times of high water in the river it is cut off for weeks at a time. It is soon to be linked with Maxicali by Government-built railroad, much of the grading has been done, but it can never be much of a port. At present it seems to be the only point which may be reached by automobile from which the bore may be observed.

We reached La Bomba at 11.30 a. m. December 9. A strong, cold north wind was blowing and having taken the lay of the land, measured the height of the bank and set stakes by which to judge the bore we took shelter in the lee of one of the houses. A mountain chain of many interlocking ranges lies some 8 miles to the west and was remarkably impressive and beautiful in the sandstorm haze. From our shelter it was possible to see some distance down the river.

The coming of the bore was first called to our attention by the disturbance among a big flock of white pelicans fully 6 miles away. Fish always follow the bore in, we were told. The brown line of the bore itself was visible with the glass at perhaps 3 miles. Its speed appeared to be nearly 8 miles an hour. As a spectacle it was disappointing. This was doubtless due in some measure to the strong north wind that had been fighting the tide all the way up the Gulf. Up to the moment that the bore, or first wave, arrived the current was running strongly seaward. In an instant it was reversed and racing up the river. The bore was not over 3 feet high, a racing wave fully a mile long, foam crested and perhaps a foot higher over the shallows and sand bars. In deep water it was like a ground swell apparently running *over* the outgoing tide and river current. The *lack of turmoil between the two opposite currents was surprising.* The level of the river rose 3 feet in the first minute and 5 feet in 15 minutes. The bank was 15 feet high at low tide. The high tide of two nights previous had filled the channel and overflowed the surrounding country 6 inches deep. Probably a full half mile behind the first wave something similar to a tide rip appeared, waves 3 to 4 feet high probably not over 20 feet from crest to crest racing up the river. They would have made very rough going for a small boat.

As contrasted with the bore we saw it is said that the first wave is 10 feet high at times. In September, 1922, a small steamer was wrecked by the bore and succeeding waves, with a loss of 130 lives. That is the sort of bore we did not see.

Because of the need of getting back to Calexico that night we did not wait to see the high tide.

Returning from Calexico to Yuma the next day the two other Yuma members of the party and I had opportunity to see the effect of the worst windstorm in years on the sand hills. Where the road crosses this "Sahara of America" the sand-hill area is about 5 miles wide. An eight foot plank road has been built through this section which would otherwise be impassable and an average of about 200 cars pass over it daily. The shifting sands have always been a problem and men with teams and scrapers are maintained at all times to keep the road clear. This storm had been too much for them. Tongues of sand crossed the road in perhaps a hundred places. Where they were not over a foot or 18 inches deep the car took them on the rush but over the most exposed portion of the road the sand drifts were 4 or 5 feet deep. Some 60 cars were tied up when we arrived, some of them had been there 24 hours and our stock of provisions left from trip was quickly disposed of. To the east it was 10 miles to food and water, to the west 5 miles to the headquarters of the road workers. The wind was blowing a gale and the sand was going with it. I have long wanted to watch a storm in the sand hills. This opportunity was ideal save for the fact that for the next six hours we were constantly busy helping others and being helped. In that time we moved forward nearly half a mile, past the worst obstructions and were at last free to go. The impression of a storm in the sand hills is not very different from that of a snowstorm; there is the unending stretch of light grey sand, huge drifts and the air filled with flying particles. I hope to spend a day there a little later in the season with anemometer and single register getting an idea of the wind movement and progress of the dunes. The problem of a road has not been satisfactorily solved and the road department would welcome any definite information. The all-American canal to the Imperial Valley is to go through the sand hills also and the Reclamation Service is anxious to secure data on sand movement as a problem for the canal.

Because of the high wind and sand haze pictures taken on the trip were not entirely satisfactory. I am inclosing a few of the best secured.

551.573 (73)

LEE ON EVAPORATION LOSS FROM WATER SURFACES: MOIST SOILS, WITH SPECIAL REFERENCE TO CONDITIONS IN WESTERN AMERICA

By A. J. HENRY, Meteorologist

[Weather Bureau, Washington, March, 1924]

[Abstract]

The author writes from the standpoint of the practical hydrologist rather than from that of the physicist. After directing attention to the increasing needs for more accurate measures of evaporation he stresses the necessity for the adoption of standard methods of observation, a subject to which further reference will be made later.

Attention is directed to the common failure of many experimenters to closely simulate in the exposure of the experimental pans the natural conditions in the lake or other body of water whose evaporation is sought. Thus floating pans submerged in a large body of water approach rather closely to the actual temperature of the lake or reservoir. In his experience the temperature of the water in floating pans made of light colored metal and kept clean does not vary more than 1° F. or 1.5° F. from that of the surrounding water.

In the matter of vapor pressure, according to the author, there is even greater departure from natural conditions. Too little attention is given to securing a free movement of the air across the pan.

The size of the pan, too, is often given too little consideration.

Concerning lack of standardization of methods of measuring evaporation from water surfaces a list of methods in general use is presented, as in the table below; the table contains in the column next to the last on the right values of the relations of the various rates to that from a 12-foot land pan set in the ground. The data are quoted from Sleight.[1]

TABLE 1.—*Various devices used for measuring evaporation from water surface*

Type	Used by—	Size	Surroundings	Relation to evaporation pan set in ground, as observed by Sleight	
				Mean ratio	Mean ratio
				Per cent	*Per cent*
Piche evaporimenter.	U. S. W. B.		In instrument shelter.		−28.5 to +42.6.
Air pan	U. S. W. B. at Reno and Salton Sea.	Various	Elevated above land or water surface.		
Land pan	U. S. W. B. standard.	4 feet diameter, 10 inches deep.	Above ground.	151.8	−14 to +19.
Land pan or tank.	U. S. D. A. and State experiment stations.	1 foot diameter, 3 feet deep.	Set in ground 2.7 feet.	155.5	−23 to +24.
	do	2 feet diameter, 3 feet deep.	do	129.9	−18 to +17.
	do	3.39 feet diameter, 3 feet deep.	do	120.2	−15 to +19.
	do	6 feet diameter, 3 feet deep.	do	110.2	−11 to +10.
	do	9 feet diameter, 3 feet deep.	do	101.1	−13 to +9.
Floating pan.	U. S. W. B. at Salton Sea.	Various	On raft		
	U. S. G. S. standard.	3 by 3 feet, 1.5 feet deep.	Submerged 1.25 feet.	[1] 108.1	−10 to +11.

[1] Applying correction determined by Sleight as 1.049, to reduce to value comparable with that from circular pans, this is 103 per cent.

A lake or reservoir, considered as a whole, has not as great an opportunity for dissipating its vapor as a pan, since escape is practically limited to the vertical direction. The perimeter of a small pan, however, is relatively large compared to its area since it varies directly with the diameter, while the area varies with the square. The vapor dissipating horizontally from a small pan thus bears an appreciable ratio to the total, while from a large body of water it is practically negligible. The ratio of the rate of wind movement to the distance across a body of water is also an important consideration.

The author holds that temperature, relative humidity, and wind movement are the controlling factors in evaporation from water surfaces.

[1] Sleight, R. B., Evaporation from the surfaces of water and river-bed materials U. S. Dept. Agri., Jour. Agri. Research, Vol. X, No. 5, pp. 209-262.